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ABSTRACT

This review and synthesis of dissertations and other research literature published between 1987 and 1993 focuses on K-12 and teacher education in technology education. It begins with an overview of the research base. The review examines the status of and curriculum development in secondary technology education and technology teacher education, finding the following: superficial changes in the name of the field and course titles; little significant change in practice; a predominance of Delphi studies for curriculum development; and lack of innovative instructional materials. Technology education appears to be a homogeneous profession, overwhelmingly male. Research about minority participation is lacking. The profession is concerned with standardizing credentials and recruits successfully, but overall there is a low level of professional participation and development. Conclusions about effectiveness are mixed, partly due to problems in methodology. The public, administrators, and teachers have positive attitudes toward technology education. However, female students still appear to feel that technology is a male endeavor. Comparisons of U.S. and foreign students indicate that U.S. students have a weaker concept of technology. Despite concern for technological literacy, little research is conducted toward this end. The review concludes with recommendations for technology education research and 228 references. (SK)

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Implementing Technology Education:

A Review and Synthesis of the Research Literature

Information Series No. 356

Karen F. Zuga

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

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A Review and Synthesis of the Research Literature

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Foreword

The Educational Resources Information Center Clearinghouse on Adult, Career, and Vocational Education (ERIC/ACVE) is 1 of 16 clearinghouses in a national information system that is funded by the Office of Educational Research and Improvement (OERI), U.S. Department of Education. This paper was developed to fulfill one of the functions of the clearinghouse—interpreting the literature in the ERIC database. This paper should be of interest to career and vocational education practitioners, administrators, policy makers, and teacher educators.

ERIC/ACVE would like to thank Karen F. Zuga for her work in the preparation of this paper. Dr. Zuga is Associate Professor of Technology Education at the Ohio State University. She is a member of the boards of the International Technology Education Association (ITEA) and the National Association for Science, Technology and Society. She served as president of the Technology Education for Children Council and as vice-president of the Technology Education Division of the National Association of Industrial and Technical Teacher Educators (NAITTE). Dr. Zuga was named Outstanding Young Technology Educator by ITEA and Outstanding Young Industrial Teacher Educator by NAITTE.

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Ray D. Ryan
Executive Director
Center on Education and Training
for Employment

Executive Summary

This review and synthesis of dissertations and other research literature published between 1987 and 1993 focuses on K-12 and teacher education in technology education. It begins with an overview of the research base that reveals the following:

- 50 percent of the research is devoted to curriculum status, development, and change.
- 63 percent focuses on secondary education.
- 53 percent studied teachers/teacher educators.
- 65 percent used descriptive methods.
- Most of the research is conducted in a few institutions.

The review examines the status of secondary technology education and technology teacher education as well as development of secondary and teacher education curricula. It finds superficial changes in the name of the field and course titles; little significant change in practice; a predominance of Delphi studies for curriculum development; and lack of innovative instructional materials.

According to studies of secondary teachers and teacher education, technology education appears to be a homogeneous profession, overwhelmingly male. Research about minority participation is lacking. The profession is concerned with standardizing credentials and recruits successfully, but overall the level of professional participation and development is low. Little research explores instructional methods and strategies in such areas as cognition, special needs, computer-assisted instruction, and problem solving, leading to discontinuity between curriculum theory and instructional practice.

The answer to the question "Does technology education make a difference?" is mixed, partly due to problems in methodology. Too often research focuses on achievement in subjects other than technology education. International researchers yielded some insight into technology education's effectiveness. The public, administrators, and teachers have positive attitudes toward technology education. However, girls still appear to feel that technology is male endeavor. Comparisons of U.S. and foreign students finds that U.S. students have a weaker concept of technology. Despite concern for technological literacy, little research is conducted toward this end.

The review concludes with recommendations for technology education research:

- Expand the use of various research methods
- Demonstrate technology education's inherent value
- Research the ideology and inherent biases in content and practice
- Develop and test innovative curriculum materials
- Promote effective professional development

Information on technology education research may be found in the ERIC database using the following descriptors: Attitudes, *Curriculum Development, Educational Research, Higher Education, Instructional Effectiveness, Research Methodology, Research Problems, Secondary Education, *Secondary School Curriculum, Secondary School Teachers, Teacher Education, *Teacher Education Curriculum, *Technology Education. Asterisks indicate descriptors that are particularly relevant.

Introduction

Over the years what is practiced as technology education has continued to evolve, making the precise definition of the field a moving target. The latest in a series of definitions for technology education was created by a team of technology educators for a curriculum framework. Technology is defined as "a body of knowledge and the application of resources using a systematic approach . . . to produce outcomes in response to human needs and wants" (Savage and Sterry 1990, p. 7). According to the latest thinking in this document, the main purpose of technology education in the schools is to prepare students to understand and participate in a technological society through experience with technological methods, resources, and knowledge. This definition outlines a very broad topic that incorporates not only the commonly accepted definition of technology as computer-based knowledge, but also all of the means by which humans modify their environment.

Technology education relates to many disciplines and fields of study. In addition, the members of the field have formed many liaisons with professionals from other closely and, not so closely, related subject fields. These liaisons make it difficult to draw precise borders around the research base for technology education, since so many different areas are intertwined and related to technology education practice. For example, technology education as a study of technology is related to all research involving the study of engineering; the history of technology; architecture; vocational education; science, technology, and society as STS; and many other topics. Moreover, technology education is a subject of international concern and a great deal of research has been and continues to be conducted around the world. These factors contribute to a large and difficult body of knowledge to review and synthesize.

Delimitations of the Research Base

As a result of the complexities of identifying relevant research to review for this study, I made decisions about what to include and what not to include. First, I took a parochial view and did focus on the research that has been published in the United States or is easily accessed from databases in the United States. This was a very practical move in that the information presented in this study ought to be accessible to readers. What international research is available was included—a rich resource that often reveals a very different view of technology education. Perhaps, by the time of the next review, there will be greater access to international documents. Second, in order to limit the research base, I focused on those studies which were primarily about kindergarten through secondary through teacher education aspects of technology education as defined and practiced in general education. This restriction caused the elimination of studies on topics that were related, but not specifically including information about technology education such as vocational education, industrial technology, engineering, and many others. To have included related studies would have resulted in an impossible task given the resource and time restrictions. The greatest loss due to this decision was the loss of research being done by doctoral candidates in mainstream technology education programs. Some of them are researching such topics as how to teach engineering students to visualize, which are related to but not focused on technology education. A separate study of all doctoral work such as the review by Foster (1992) may be insightful for technology educators in that it should demonstrate the breadth of interest and the potential evolution of technology education. Third, I limited the review to journal articles and databases related to technology education as defined and delimited by the field of practitioners represented both in the International Technology Education Association (ITEA) and the Technology Education Division of the American Vocational Association (TED-AVA). A page-by-page hunt for research that was considered to be about technology education was conducted in issues from 1987 through 1993 of the following journals: the ***Journal of Technology Education***, the ***Journal of Industrial Teacher Education***, the ***Technology Teacher***, the ***Journal of Epsilon Pi Tau*** (recently renamed the ***Journal of Technology Studies***), and the few issues of ***Journal of Technology and Society*** that were published as a precursor to the ***Journal of Technology Education***. After looking at the other magazines and journals related to the field of technology education such as ***Tech Directions***, ***Industrial Education***, and ***TIES***, I eliminated them because they did not focus on research reporting. Two databases that include most of the research about technology education existing in other journals and documents—the Educational Resources Information Center (ERIC) and ***Dissertation Abstracts International***—were searched. Each paper found in the ERIC system and each abstract found in ***Dissertation Abstracts International*** was reviewed.

On two factors, I did not severely delimit the search. Unlike the McCrory (1987) study, I used a liberal definition of research. Included in this review are not only the traditional quantitative studies, but also studies that would be classified as historical, qualitative, and conceptual analysis. Essentially, if a study qualified as one of the research efforts mentioned here, it is included. Related to that is the factor of quality. Since most of the studies are flawed in some way, all are included. Some of them are critiqued in the text, but readers are urged to read each study that they are interested in using to determine its quality before using it.

Number of Studies Identified

As a result of the delimitations upon the research base, a total of 220 reports of studies were identified. There are 115 professional research reports. Those are research reports which have been published in journals or identified through the ERIC system as conference papers or project reports and are available on microfiche. Duplicates of the professional research reports have occurred in two ways. Occasionally, an author has more than one article about a study or has a conference paper and an article about the study. More frequently, a professional research report appears as an article that is based upon a dissertation. Duplications of dissertations and professional research reports were not eliminated in the total count. A total of 105 dissertation abstracts were reviewed. No master's theses were included.

The remainder of this report is divided into sections that deal with an overview of the entire research base; topics of technology education research created from the research base such as curriculum, instruction, effectiveness of technology education, and others; and a critical discussion of the research base and the omissions from the research base.

Overview of Reports

As I compiled the research base for the past 7 years, I realized that some summary information might be helpful in creating a thumbnail sketch of the research in the field. Therefore, I have compiled some tables that address several questions one might have about the general direction of the technology education research effort. These questions deal with descriptions of the research base: What we are studying? On what level of technology education are we focusing? How are we conducting studies? Who are we studying? and Where is the research being done?

What Is Being Studied?

Technology education researchers are focused on the curriculum.

What topic is it that has captured the interest of technology education researchers? Is it the quest to demonstrate the value of technology education? Is it providing data that demonstrate that technology educators are achieving their goals? Is it searching for an identity for technology education? A quick look at a classification of research studies by topic reveals that technology education researchers are focused on the curriculum.

TABLE 1
TOPICS STUDIED IN TECHNOLOGY EDUCATION RESEARCH

	Dissertations		Professional Literature		All Reports	
	f	%	f	%	f	%
Curriculum Status	13	12	29	25	42	19
Curriculum	20	29	12	10	42	19
Development	10	9	17	15	27	12
Curriculum Change	13	12	26	23	39	18
Professional	19	18	16	14	35	16
Instruction	13	13	9	10	22	10
Effectiveness	7	7	6	5	13	6
Attitudes	105	100	115	100	220	100

Table 1 is an interpretation of the topics technology education researchers are studying. Another researcher may have identified different categories, but it would be difficult to ignore the focus on curriculum. Half of technology education research (50 percent) is devoted to studying curriculum with professional issues such as certification, organizations, and professional roles taking up 18 percent of research, relegating all other research topics concerning effectiveness of technology education and topics such as technological literacy and problem solving to far less than half of the research.

What Level of Practice Is Studied?

Most of the research effort relates to secondary education.

Knowing that curriculum was the most frequently studied topic, at what level the curriculum is studied is another question that might be of interest. Since most researchers are teacher educators, one might presume that teacher education is of great concern, but it is not. In the policies of the ITEA and the program articles in the ***Technology Teacher***, there is a growing interest in technology education at the elementary school level, but that has resulted in little research. Technology education researchers seem to reflect their own experiences and most of them have been associated with secondary-level technology education as teachers and teacher educators. Most of the research effort (63 percent) relates to secondary education either through studies directly focused upon the schools or through teacher education for secondary certification.

TABLE 2
TECHNOLOGY EDUCATION LEVEL OF THE STUDIES

	Dissertations		Professional Literature		All Reports	
	f	%	f	%	f	%
Secondary	72	69	65	57	137	63
Teacher Education	16	15	35	30	51	23
Combined	14	13	13	11	27	12
Elementary	2	2	2	2	4	2
Public	1	1	0	0	1	0
	105	100	115	100	220	100

The reader may note that there is one study which deals with the education of the public. This study is from Great Britain where there has been an effort to work with the community through technology centers. It would be interesting to explore this difference in approach to technology education and the research available in Great Britain.

Who Is Being Studied?

53 percent of the studies use educators as the prime population.

The populations of interest in technology education studies reveal another aspect of the approach to research being taken. One might conclude that students would be a primary population for research about technology education, if researchers were primarily interested in the influence and value of the field. When researchers are trying to identify a content base and verify the practices of technology educators, the population of interest becomes the educators. If teachers and teacher educators are combined as the populations used in research, 53 percent of the studies use educators as the prime population. If state supervisors of technology education as educators are added, the percentage increases to 59 percent of the populations studied.

TABLE 3
POPULATIONS STUDIED IN TECHNOLOGY EDUCATION

	Dissertations		Professional Literature		All Reports	
	f	%	f	%	f	%
Students	26	25	25	22	51	23
Teachers and Teacher	22	21	23	20	45	21
Educators	17	16	25	22	42	19
Teachers	9	9	20	17	29	13
Teacher Educators	13	12	9	8	22	10
Literature	3	3	9	8	12	6
State Supervisors	6	5	1	1	7	3
Administrators	3	3	2	1	5	2
Industrialists	5	5	0	0	5	2
Unknown	1	1	1	1	2	1
Citizens	105	100	115	100	220	100

Given the difficulty of identifying national samples, the two most frequently used national populations from which samples were drawn were the teacher educators listed in the ***Industrial Teacher Education Directory*** and state supervisors for technology education.

How Are Studies Being Conducted?

Although there are a variety of forms of research, the consistency with which the field conducts quantitative research is interesting. Historical, qualitative, and conceptual analysis are kinds of research that have all been practiced since the beginning of this century and, as in the case of historical research, many years before that. Yet, 83 percent of technology education research is quantitative research. Moreover, the preponderance of quantitative research that is conducted is primarily descriptive research! Since 65 percent of the research effort is expended upon descriptive research, this gives rise to more questions about the research base. It appears as though technology education researchers are stuck on first base in the hypothetical-deductive research loop that quantitative researchers use to describe the evolution and maturity of research in a field. In theory, according to those who promote quantitative research, good descriptive work is supposed to lead to creating the hypotheses needed for correlational and experimental work, which, in turn, create theories (Van Dalen 1979).

83 percent of technology education research is quantitative research. Moreover, the preponderance of quantitative research that is conducted is primarily descriptive research!

TABLE 4
METHODS USED IN TECHNOLOGY EDUCATION STUDIES

	Dissertations		Professional Literature		All Reports	
	f	%	f	%	f	%
Descriptive	64	61	79	68	143	65
Correlational	15	14	9	8	23	11
Qualitative	6	6	9	8	16	7
Quasi-experimental	7	6	9	8	16	7
Historical	9	9	2	2	11	5
Content Analysis	4	4	7	6	11	5
	105	100	115	100	220	100

Curiously, it is in the method of research that differences between the international and U.S. research studies begin to emerge. Although the sample of international studies is quite limited, of the international research that is accessible in the United States, the methods used by international researchers diverge with more researchers from outside the United States using a variety of methods of which qualitative research is more prominent.

What Institutions Are Supporting Research?

As technology educators try to develop a research base for the field, encouraging that research base to grow should be of some interest to the profession. The question of which institutions are places where research is being done relates to this concern and further describes the research database. There are 89 institutions which have been identified with the research reports for technology education. At least 18 studies were identified with 2 or more institutions. Of those institutions mentioned in the review, almost all of them are universities and colleges with the exception of one association (the ITEA), one magazine (***School Shop/Tech Directions***), and a few public schools. Of the institutions identified in the research reports, 60 of the 89 institutions are listed only once and 8 of them are listed twice, leaving 21 institutions being identified with 3 or more studies and 7 institutions identified with 10 or more studies. It appears that there are a very few institutions where the bulk of the research is being conducted.

It appears that there are a very few institutions where the bulk of the research is being conducted.

Although institutional support and encouragement to do research is an important factor, a quick and cursory look at the reference list of studies provides another insight into who is doing research. It appears as though the research effort is more closely tied to people than to institutions. Other than in doctoral degree-granting institutions where variety is due to dissertations, a few researchers at each of the institutions that have supported professional research seem to be responsible for the larger portion of studies at each institution. In some cases all of the research efforts of an institution are the result of a single person. It appears that the research which is conducted in the field rests in the hands of a small group of researchers.

Summary

This is a brief sketch of the entire research database for this review. What this kind of an analysis reveals is that the research base is focused on the curriculum, is primarily descriptive, relates mostly to technology educators' ideas and practices, is concerned with secondary school technology education, and is the result of a small number of researchers working at a handful of institutions. At this juncture, one might characterize this research as narrowly defined and inwardly focused.

TABLE 5
INSTITUTIONS SUPPORTING RESEARCH*

	Dissertations	Professional Literature	All Reports
	f	f	f
Ohio State University	10	5	15
Texas A&M Univ.	9	6	15
VA Polytechnic Institute	5	6	15
University of MD	9	4	13
Iowa State University	7	5	12
University of MN	4	7	11
NC State University	2	8	10
ITEA	0	7	7
OK State University	5	2	7
School Shop/Tech Directions	0	7	7
WV University	6	1	7
IL State University	0	6	6
Northern IL Univ.	0	6	6
University of Georgia	1	5	6
CO State University	3	2	5
IN State University	3	2	5
University of Illinois	2	2	4
University of TN	2	2	4
Millersville State Univ.	0	3	3
University of MO	2	1	3
Univ. of Northern IA	2	1	3

61 institutions listed once
9 institutions listed twice

*18 studies were done cooperatively with two or more institutions leading to a total that exceeds the total number of research reports identified in this review.

The Curriculum Fascination

Clearly, the most researched topic in technology education is the curriculum of the field. Perhaps the constant evolution of technology and the attempt to represent it as a subject for educational study in the schools creates this concern. The studies that relate to curriculum can be grouped into three broad categories relating to status, content, and change. Within each category are further distinctions among the studies, some of which relate to the level and others of which relate to the particular approach to the study through the problems identified and the methods used.

A number of studies could be characterized as "snapshots" of technology education. These studies are surveys that have been done in order to answer the basic question of what is happening in the schools, either in the secondary schools or in teacher education. Researchers have attempted to provide information about the courses that are being taught and some of the attitudes held by the surveyed populations about those courses. The studies relate to either secondary or teacher education. Some of the researchers have attempted to sample a national population whereas others have focused on a state or other locality.

Status of Secondary Technology Education

Studying the status of technology education has been approached in a variety of ways. Researchers have relied upon asking teachers, state supervisors, and principals as well as reviewing the literature of the field. These efforts have resulted in demographic data, surveys of attitudes, and conceptual structures that are used to explain technology education curriculum.

Demographic Descriptions

In an attempt to provide continuous information about the status of technology education by looking at what is taught, a team of researchers tried to collect yearly data through voluntary surveys of the readers of ***School Shop***. Studies by Dugger, Fowler, Jones, and Starkweather (1988b); Dugger, French, Jones, and Starkweather (1990); and Dugger, French, Peckham, and Starkweather (1991, 1992) appeared as a series of attempts to provide national data on the status of the field. Each study suffered from the use of reader return surveys that were inserted into the magazine and each study had such a low response rate that the data presented in them are questionable. Given the problem with the sample, the main information contained in these studies—the reported frequency of course offerings in technology education—may be of limited use.

In a 1987 snapshot of technology education, Bender surveyed state supervisors with a 90 percent return rate and reported that industrial arts was still the most frequently used name for the field in each state. At that time 29 state supervisors indicated that industrial arts was used in their states, 5 indicated that industrial technology education was used, 5 indicated that technology education was used, and 3 indicated that industrial education was used. Forty-one of the 45 supervisors who responded also indicated that they endorsed technology education. A summary of new curriculum content related to technical products and processes such as robotics, lasers, and fiber optics was also provided by Bender. Addressing the question of what name was used in each state and what curriculum structure was recommended, Wiens (1990) reported on the changes in state guidelines for technology education curriculum. Surveying the state supervisors for technology education and securing a 60 percent return, the supervisors reported that the most frequently used name for the field was industrial technology education (41.9 percent) with technology education coming in second (32.3 percent). Moreover, 75 percent of the supervisors said that they had changed the name of the field since 1985. The supervisors also reported that 40 percent of the states were using the construction, manufacturing, communication, and transportation configuration of curriculum with an additional 20 percent and 10 percent of the states varying that configuration by adding power and energy, respectively. Wiens also reported that 16.7 percent of the states used some alternate innovative configuration of content in guidelines, whereas only 3.3 percent of the respondents reported a traditional industrial arts configuration of courses.

Corroborating the changing status of technology education, Oaks (1991) found with a 98 percent return rate of state supervisor surveys that 44 states had either changed or planned to change the name of the field to technology education or industrial technology education and that the technology education adaptive systems curriculum configuration had "been adopted to some degree in 49 states" (p. 66). Putnam's (1992a) study of state supervisors had a 98 percent return rate; 71.4 percent of the respondents were committed to using the adaptive systems curriculum configuration and 34.7 percent of the states used the term technology education. He analyzed his data regionally and found a strong orientation to technology education in the northwest, midwest, and east central regions of the country, whereas the western, northeast, and southeast regions still used vocational orientations to the field.

In a dissertation abstract Greer (1991) reported on a national survey of state supervisors and found a change from industrial arts to technology education corroborating much of what other researchers have said. Hill (1990) compared how the move toward academic excellence was influencing change in the United States and Canada and found some similarities, but no mirrored patterns. In Canada she did note that change was taking place in technology education with newer courses being added in favor of dropping some traditional courses such as metalworking.

Closely related to studies of content were the studies which described other factors relevant to technology education curriculum. The team of Dugger, Fowler, Jones, and Starkweather (1987, 1988a, 1989) used an approach to studying the curriculum status by surveying state supervisors of technology education. These studies had a much more clearly defined population to access than previous studies by this team and provided an average return rate of 70 percent from that population. Over the 3 years that these studies were conducted, the responses show an increase in supervisors who had adopted national technology education standards and curriculum, a decrease in funding, and an increase in the academic requirements in each state.

One of the innovations being adopted by some technology educators has been the course, Principles of Technology, which was developed by the Center for Occupational Research and Development (CORD). Carter and Atkinson (1990) provided some demographic data about the current status of this program. In a survey of teachers, teacher educators, and state and provincial supervisors in the United States and Canada, they identified 39 states and provinces that had 550 Principles of Technology programs at the secondary school level. Although this represented a new addition to the technology education curriculum in some locations, the extent of the variation is difficult to assess since this program has been located either as a technology, vocational, or science education course. Moreover, Carter and Atkinson did not provide specific information about the relationship of the Principles of Technology programs to technology education.

Four dissertations and one evaluation study reported local information about technology education. One dissertation abstract reported on industrial arts in Malang, Indonesia (Moechid 1989) and the evaluation study reported on the Willowdale, Ontario, program in Canada (Sangster and Fagan 1988). Each of these international programs were described as industrial arts programs with a traditional industrial arts curriculum. Finding similar results in Delaware, David (1991) completed a descriptive study of technology teachers and found that the traditional courses of woodworking, metalworking, and drafting were the most frequently offered and had the most enrollment. Teachers reported that the most important goals were to use tools, materials, machines, processes, and technical concepts and to develop student skills, creativity, and self-concepts. In other international research Mole (1989) conducted an ethnographic case study of the socially directed technology policy of the Greater London Council and discussed implications for technology education, especially the education of adults. Yang (1991) assessed the status and needs of an educational computer network in secondary technology education in Taiwan, finding differences between current and ideal circumstances.

In the studies conducted in specific locations, researchers suggested that change has not taken place at the school level.

There are evident changes in technology education status described in these studies. These changes have taken place through the leadership of state supervisors who have assumed a leading role in creating change in technology education. There were no conclusive data about how many schools in each state comply with state recommendations. This leaves the field with no clear national snapshot about what is being done in technology education in schools. In fact, in the studies conducted in specific locations, researchers suggested that change has not taken place at the school level.

Attitudes and Perceptions

Taking another cut at the problem of describing technology education, several researchers asked teachers about their perceptions of the field and its status. Scarborough (1989) conducted a national survey of 1,607 teachers who had been identified by state supervisors with an 18.5 percent return. Although in agreement with technology education goals, most of these teachers still believed that skill instruction was important content.

Foregoing national samples in favor of more easily identified state samples, several doctoral candidates reported in dissertation abstracts about the status of technology education. In Nebraska Larson (1987) had teachers, teacher educators, principals, and school board presidents rate technology education program goals. Teachers rated traditional goals for industrial arts higher than the other educators who all rated the contemporary technology education goals higher. A similar study conducted by Morton (1989, 1991) had technology teachers and vocational teachers rate goals from both the traditional and the newly introduced technology education programs in Minnesota. He found significant differences between the attitudes of the committee members who created the newer curriculum and those of the teachers. In an attempt to determine if the teachers were thinking about a different future for the field, he obtained rankings of present and future attitudes about the goals. With respect to present programs, teachers ranked skill development first and with respect to future programs, teachers ranked problem solving first. Heidari (1990) surveyed teachers and principals in Idaho for perceptions about the status of technology education. Although teachers reported that they had changed to technology education and were happy with the change, principals believed that the content of the courses had not changed, even though the name had. Kuang-Chao Yu (1991) surveyed three groups of technology professionals in Virginia—leaders/teacher educators, local supervisors, and teachers—in order to assess their emphasis on selected technology education goals. The professional leader group held different beliefs from the local supervisors and teachers who held similar beliefs. In 1991 Cox used qualitative methods to study technology education in two Ohio middle schools. Using teacher and student interviews and curriculum documents to triangulate evidence, he determined that only two general education goals were in play in the technology education classes, whereas six general education goals were not identifiable, leading him to question if these programs were prevocational rather than general/liberal education.

These studies of perceptions point to a difference of opinion held by technology teachers and school principals as well as leaders in the field. Despite some agreement about the new goals, teachers do not appear to have accepted the new goals for technology education even though they have accepted a change in terminology. This could be a result of the relative newness of the goals and the difficulty of conceptualizing how to put them into practice.

The status of technology education in secondary (7-12) education has changed over time, but those changes have taken place very slowly and do not appear to be practiced widely in the schools.

Conceptual Frameworks

Two researchers addressed the status of curriculum structure in the field by creating a *post hoc* conceptual structure of technology education curriculum from the literature of the field. Working on a line of research reported first in 1986, Zuga (1988, 1989, 1993) introduced a conceptual structure of curriculum designs derived from general curriculum literature. She correlated those designs with technology education curriculum goals and evidence from curriculum documents and concluded that most technology education curriculum literature was primarily technical in both content and method, aligning it more with vocational and prevocational education than general education. A conceptual structure using the same number of categories with similar names was used by Herschbach in 1989. His conclusions were similar to Zuga's in that the technical curriculum design was considered to be prevalent in technology education.

Summary

The status of technology education in secondary (7-12) education has changed over time, but those changes have taken place very slowly and do not appear to be practiced widely in the schools. Several researchers found that although teachers have accepted some terminology change, they have not moved very far away from traditional goals in the field. Studies of teachers' attitudes about the curriculum indicate no significant shift from traditional conceptions of industrial arts to more contemporary ideas of technology education.

More complete change and adoption of technology education has occurred with the state supervisors, almost all of whom have instituted new state curriculum guidelines for contemporary technology education programs. Change in the field has been initiated and the state supervisors appear to be part of a national network for supporting and leading that change. Perhaps it is easier to write state curriculum plans and goals than to implement change in classrooms.

Underlying the outward signs is a body of literature that exhibits the tendency toward superficial change. Although terminology has changed, careful analysis of both the literature and teachers' practice suggests that the change has not been complete. As a part of the complete picture of the status of technology education, teacher educators also received some scrutiny.

Status of Teacher Education

Recently, researchers began looking at aspects of the status of teacher education. Their studies identified the content of teacher education, teacher educators' attitudes and perceptions, and the relationship of teacher education to the increasing numbers of industrial technology programs.

Content

Several researchers looked at the general nature of teacher education programs in the United States. Lewis (1991) surveyed the research literature of both general education and technology education in order to determine whether the general educational environment was influencing technology teacher education research. He identified five currents of thought in educational research, but little influence of those trends in technology teacher education. Lee (1991, 1992) described teacher education in the United States in order to compare it to Taiwanese teacher education. He found that teacher education programs had a breakdown of about 25 percent professional education courses, 25 percent technical courses, and 50 percent general education courses. The general education component in the United States exceeded that which was required in Taiwan. About half of the states mandated technical content related to contemporary technology education systems, 38 mandated testing for certification, about half of them required the National Teachers' Examination (NTE), and admissions and graduation standards continued to rise nationally. Miller (1991) surveyed department chairs identified in the ***Industrial Education Teacher Education Directory*** and found a similar distribution of courses with a specific look at how many hours of science and mathematics were required for students. Householder (1993) also conducted surveys using the same population with a 93 percent return and similar information. He also identified 139 teacher education programs, with 3,220 students, and 706 graduates for the year.

Two researchers explored aspects of the technical content of teacher education. In 1987 Dunlap and McMurray surveyed teacher education program chairs to identify how many of them were including robotics instruction. They found that 54 percent of the programs included such instruction and that there were plans to add or increase robotics instruction in 84 percent of the programs. Brown (1993) looked at approaches to teaching technical content. He studied three programs that had three distinct patterns of teaching technical content: one program faculty had all technical content separated from professional content, one program faculty mixed professional and technical content in courses, and one program faculty did not teach technical content, but had students take technical courses from another faculty group. He found that the distinct separation of professional and technical content in courses led to a lack of control and the evolution of technical courses which led them to be more abstract and less suited to teacher education.

Zuga (1991) looked at the way in which teacher educators thought about and taught curriculum courses in order to explore the theory/practice gap between what the field believed about technology education and what the field practiced. The texts and practices used within the curriculum courses for undergraduate students were suggested as a problem in that they were mostly texts and practices designed for vocational educators. In his dissertation Peck (1992) surveyed 83 methods instructors in order to identify methods practiced in technology teacher education. He also concluded that there was a theory-practice gap in that the methods of instruction practiced by the instructors were inconsistent with the theory of the field.

Attitudes and Perceptions

Seeking to identify teacher educators' attitudes about technology education, Lewis' (1992a,b; 1993) survey found that there was consensus about what the curriculum content of the field should be. It "was deemed by the respondents to be innovative curricular areas (manufacturing, construction, transportation, energy, etc.)" (Lewis 1992a, p. 27). Most teacher educators conceived of technology as applied science. Interestingly, ITEA membership was related to some of the teacher educators' beliefs about technology and emphasis on general education. He also indicated that teacher educators rejected a 5-year plan for teacher education, but appeared to be open minded on a number of potential curriculum reforms. Householder and Boser (1990, 1991) used a Delphi process to interview a small group of selected teacher educators about the changes in technology teacher education. They developed and presented a rank-ordered list of criteria and strategies for determining change in technology teacher education. Strategies included interviewing teacher educators, department leaders, students, and principals who have hired program graduates; inspecting course documents and facilities; and observing classes and student activities.

Industrial Technology

Two researchers asked if the growth of industrial technology and the relationship of industrial technology to technology teacher education were interacting. Parish (1988) found that 82 percent of the industrial technology programs evolved from technology teacher education programs. Following job market trends and a demand for graduates of teacher education in industry, the industrial technology programs were created. The influence of the growth of those programs, however, was to eliminate the professional teacher education courses from the new program and to replace them with business courses. Volk (1993a) hypothesized that the relationship between technology education and industrial technology was harmful. He found that over the 20-year period of the inception and growth in industrial technology there had been a 54.9 percent reduction in all teacher education programs with a 72.7 percent decline in technology teacher education programs associated with industrial technology programs and a 52.9 percent decline in technology teacher education programs that were not associated with industrial technology. The decline of technology teacher education associated with industrial technology programs was found to be significant, which supports the idea that industrial technology programs could be harmful to the survival of technology teacher education.

Summary

Teacher educators have, much like the supervisors, accepted the technology education curriculum change. The evidence for what they are doing about it in their courses, however, is not very clear. Teacher education programs have several components of coursework, but what those components include is in question. There is also evidence that what teacher educators say about curriculum beliefs may not match their practice. Most disturbing, though, is the relationship between industrial technology programs and teacher education programs. This relationship is often characterized as mutually beneficial, but the results of research indicate otherwise; technology teacher education may be being harmed by the relationship, both with a decline of enrollment and inappropriate courses.

Most disturbing, though, is the relationship between industrial technology programs and teacher education programs. . . . technology teacher education may be being harmed by the relationship.

With respect to the entire picture of curriculum status, the research appears to be pointing toward a theory-practice gap for practitioners of technology education. The pronouncements and name changes do not match the practices of the profession. This tendency toward a theory-practice gap is evident with teacher educators who have aligned their programs with an industrial technology postsecondary vocational education, as well as with teachers who still value traditional industrial arts goals.

Development of Secondary Education Curricula

Research and development efforts were conducted for the purpose of creating new curriculum content. Those efforts were both at the secondary and teacher education levels. Approaches to developing content were varied with researchers attempting to create philosophical foundations for the field, frameworks of curriculum content, and lists of great books.

General

Tsiantis (1989) looked at the Greek conception of "being" as *physis* and how it relates to the essence of technology in order to develop a foundation and framework for technology education in Greece. A philosophical study was completed by Ramer (1990) in order to reconceptualize a philosophical foundation for the field. He examined technology education, liberation theory, multiple perceptions of truth, and technological thought literature in order to describe a rationale for emancipatory technology education. In 1991 Custer analyzed the literature in order to define technology. His analysis warned of the need to unify social and human cultural contexts with procedural knowledge of technology.

Several researchers used surveys in order to create curriculum frameworks. In Kentucky M. H. Williams (1987) surveyed teachers to develop competencies essential for technology education. P. J. Williams (1987, 1989) surveyed Seventh Day Adventist teachers, principals, and regional directors in order to develop standards for their schools. Lo (1992) surveyed professors, teachers, administrators, and senior undergraduates in order to determine curriculum guidelines for Taiwan. Each of these general studies provided guidelines for technology education that were embedded in a specific point of view. Wicklein (1993a) experimented with the Developing a Curriculum Method (DACUM) designed by vocational educators for the purpose of developing vocational curricula and developed a process-based curriculum for technology education. Volk (1990, 1993b) used a Delphi approach to create 35 curriculum guidelines for developing countries.

Technological Literacy

Some researchers have tried to define technological literacy for the purpose of curriculum development. Baker (1988) used a

Delphi method to created a list of characteristics for a technologically literate person. Knowledge of concepts and communication and problem-solving skills were judged to be the most important characteristics of technological literacy. Gilberti (1989) traced the historical roots of technological literacy and tied it to the social efficiency era in the early part of the century. In 1990 Barnette surveyed experts and identified 53 concepts of technological literacy on which engineering and technology educators differed with STS educators. In 1990 Croft used a Delphi method and a panel of experts and generated a list of 24 characteristics of technological literacy. Technological literacy was a topic of concern for Lewis and Gagel (1992) as they created a concept analysis of the term from the literature in order to further define it for the profession.

Adaptive Systems Content

Specific adaptive systems content was addressed by a number of researchers. Manufacturing curriculum was studied by Nowak (1988) and Merrell (1990, 1992). Nowak used a Delphi method with teachers as panel members to identify teaching strategies and learning activities for manufacturing. Merrell had industrial personnel representatives evaluate a proposed manufacturing curriculum. From their point of view the industrialists did not judge the courses to be very important. Several other researchers used a Delphi method:

- Beauvais (1987) to identify new techniques in construction to be included in secondary curriculum;
- Becker (1988) to identify content and strategies for teaching computer-aided drafting;
- Kalk (1992) to identify communication content; and
- Wells (1992) to develop a taxonomy for the study of biotechnology in secondary technology education.

A unique approach to providing curriculum information was taken by Litowitz (1988b) in a review and critique of textbooks available for energy, power, and transportation. He found a lack of books available for teacher education, and many of the books he reviewed failed to make connections between concepts. During the same year, Pytlik (1988) used a Delphi method to generate a list of great books of technology. He categorized and provided a list of the books suggested by his panel of experts.

Integrating Content

A number of researchers studied specific aspects integrated within technology education curriculum. Using a Delphi panel, Wright (1987) created outcome statements for the use of jigs and fixtures in manufacturing courses. Smallwood (1988, 1991) tried to identify a list of worker characteristics needed in order to effectively use participative management strategies. He identified 25 characteristics and offered them as components of technology education curriculum. Karian (1991) had a panel of experts rate environmental instructional outcomes and developed a list of 52 objectives. In 1992 Wang surveyed environmental journal editors in order to identify 58 critical issues for secondary technology education. In the Netherlands, deVries (1988) developed a course that integrated technology into physics. Mathematics integration was the topic of Dennis (1989) who studied curriculum guides and surveyed Louisiana secondary technology education teachers to generate a list of 173 mathematics-related objectives from the guides and 753 objectives as reported by teachers. Integrating technology education with science or science and social studies education intrigued Cheek (1989) in his dissertation work that provided a conceptual framework for teaching STS.

Summary

A number of the curriculum development studies were done using Delphi panels. The use of this technique for generating curriculum exhibited an extraordinary faith in expert opinion. In addition, personal philosophy and interests influenced the way in which the studies were conceptualized from the selection of method and the questions which were asked. The result was that the areas that concerned researchers did not combine well to make a whole. The pattern of curriculum development for secondary education appears uneven.

Development of Teacher Education Curricula

Several researchers conducted studies for developing teacher education curricula. As with secondary technology education curricula, researchers approached identifying content for teacher education in general and selected adaptive systems and with selected content integrated within technology education.

General

In 1987 Lacroix surveyed Minnesota teachers in order to identify the characteristics of good technology teachers for the purpose of developing professional curriculum. The teachers responded with suggestions that were used to create a rank-ordered list in which enthusiasm, good attitudes towards students, subject knowledge, organization, and communication were the first five characteristics. Using a slightly different approach, Ristow (1987) did a needs assessment of Idaho's technology teachers in order to determine what teachers need to know, both pedagogically and technically. At that time he found that information about the adaptive systems and computer technology topped the technical list whereas curriculum development and motivation of students topped the pedagogical list. A suggested list of courses for all of technology teacher education was provided by McClain and Zitello (1990). They derived their list from surveying state supervisors and teachers. Horath (1990) took a different approach in his dissertation and identified technological proficiencies that teachers should possess by surveying 131 members of the National Association of Industrial and Technical Teacher Educators (NAITTE) and the Council on Technology Teacher Education (CTTE) using a Delphi method. He produced a rank-ordered list of proficiencies perceived to be important by this group. A related effort was undertaken by Newberry (1992) who used a Delphi method to identify cognitive and psychomotor competencies needed by technology teachers in secondary schools. He provided a list of 53 most essential competencies and 102 essential ones.

Adaptive Systems

Communication and transportation were the systems most frequently studied by researchers. Bell (1992a,b) used a Delphi method with a panel of 12 experts in communication, teacher education, and state and local supervision to identify 20 general curriculum guidelines for communication technology teacher education. Rouch (1989) provided a list of transportation curriculum outcomes by surveying experts in transportation to develop learning outcomes and technology educators to rate the current level of emphasis on the outcomes. He provided not only a list of what is being emphasized, but also a list of what should be emphasized in technology teacher education.

Integration

Integration of content into technology teacher education was the topic of several dissertations. Hsiao (1987) created a list of 25 generic microcomputer competencies by surveying 144 teacher educators in 36 selected midwestern technology teacher education programs. In 1992 Rokke used a Delphi method with a panel of technology, physics, STS, and new liberal arts educators to create a list of 26 organizing and esoteric concepts of physics that should be known by technology teachers.

Summary

The pattern in teacher education curriculum development is as sporadic as curriculum development for secondary education.

Clearly, the Delphi method has become a popular means of identifying curriculum content for technology education. The Delphi method was originally developed as a means of predicting the future by getting futurists to agree upon the most plausible scenarios. The method works by surveying people several times, each time selecting mean responses and dropping both plausible and implausible responses that are chosen infrequently. In theory, this process offers expert opinion, but it is expert opinion that has been forced to the mean by the process of repeated rankings of choices on surveys. The use, especially the extensive use of this method for curriculum development, ought to be questioned by researchers since the method forces the group of experts to the mean, thereby ignoring the very expertise that has been sought.

Researchers provided some information about the patterns of professional and technical courses and suggested content for specific aspects of each. The pattern in teacher education curriculum development is as sporadic as curriculum development for secondary education leading to difficulty in identifying a coherent body of knowledge about curriculum content.

Curriculum Change

A concern for curriculum change in technology education appeared in the status studies of the field and there were many studies devoted solely to change. Most studies were focused on the secondary level of technology education. Researchers took a variety of methodological approaches to the study of curriculum change with several doctoral researchers looking at the history of change in the field, a number of other researchers attempting to assess factors influencing or resulting from change, and more researchers attempting to identify teachers' attitudes about change.

Historical Reflections

Historical researchers of change used a variety of approaches to delimiting the eras and the scope of the study. Snyder (1992) traced the transition from industrial arts to technology education in the nation through a focus on program and policy goals. McLaughlin (1991) looked at a facet of technology education, the environmental movement, throughout the history of the field from 1875 to 1985 and found evidence of a continuing environmental concern in the practice of technology education. LaPorte (1987) explored early arguments against including manufacturing in manual training. There was a general disdain for industry, a belief that manufacturing courses would exploit students, and a belief that the values of manual training would be lost. Herschbach (1992) studied the early kindergarten movement and its links to industrial education. He found a significant role played by women who set up a dichotomous system within industrial education by rejecting the values and purposes of the vocationally oriented industrial educators. Coy (1987) studied the influence of manual training on the Seventh Day Adventist educational system and identified ways in which manual training was a part of the foundation of that educational system. In Finland, Kananoja (1989) traced activity education as a part of general education and provided a philosophical foundation for modern technology education.

In more select locations, Lakes (1988) linked art education to industrial arts in the Cincinnati Public Schools as he explained the evolution in the early 20th century and the influence of industrial capitalism on the field. Loucks (1991) provided information similar to Lakes in a study of manual training in Dayton from 1886 to 1920. She tracked the values within society of that time that shaped the prevocational, masculine, and classist nature of manual training, illuminating the early beginning of current values in technology education.

These historical studies identified the roots of problems that continue to plague the field. They did not offer solutions; they pointed out the sources of some of the capitalistic, vocational, masculine, and classist values and ideas that have grown to be a part of the ethos of the profession. As for change, these studies can help explain why technology education evolved in the ways in which it has.

Factors Influencing Change

Attempting to find more contemporary explanations about the evolution of technology education and the further influence that change has upon the future of the curriculum of the field, several researchers studied the change process.

Researchers documented factors influencing the process of curriculum revision with teachers in a variety of ways. Scarborough (1988), Boser (1989), and Young-Hawkins and Mouzes (1991) all provided straightforward documentation of several specific curriculum revision processes through quantitative and qualitative research methods. Their reports included little interpretation, but did have examples of strategies that worked in the locations they observed. Some of those strategies included the value of including teachers in planning and implementation and providing time for inservice education. Treagust and Rennie (1993) used ethnography to track the introduction of technology education in Australian schools. Their report included some interpretation by identifying reasons for the success or failure of some of the programs. Reasons for failure included a dependency on one supervisor, a high turnover in staff, and a lack of coordination during staff changes. Reasons for success included effective communication, each teacher taking responsibility for change, and continual support from the principal.

The influence of ideology appears, again, in a study done by Zuga (1987) as she interpreted the evidence of a year of observing teachers struggling to revise their schools' curriculum. Her conclusion was that they are trapped in a technocratic ideology that kept them from transforming skill-based industrial arts practice to technology education for general education. Scarborough (1993a,b) reported in a qualitative style on a curriculum project that was created in order to integrate physics and mathematics with technology education. These reports provided insight into the effort of creating integrated curriculum programs and focused on teachers' perceptions of the benefits and problems associated with creating curriculum change that is integrated. Students exposed to the program showed a higher interest in science. Teachers realized the value of integration and other benefits with respect to professional growth and improvement in teaching.

In dissertation abstracts two researchers reported on the factors and consequences of change. In Indiana Steck (1990) identified teachers' belief that change was needed, but that appropriate classroom materials were scarce. Studying middle-school pilot technology teachers, Komacek (1987) underscored the importance of appropriate materials in New York where the availability of materials contributed significantly to change. In addition, he found a combination of action steps that interacted to contribute to change.

Themes emerging concerning the factors that influence change include the need for support from the administration and curriculum materials. In addition, the ideology of the professionals appears to be a major stumbling block creating a theory and practice gap in technology education. Examining teachers' attitudes further reinforces the idea that ideology may inhibit change.

Teachers' Attitudes

Several researchers studied the perceptions of teachers with respect to curriculum change. A body of coordinated research appears to be growing.

In 1988 Hatfield asked Tennessee teachers about their agreement with the new curriculum model for the state. He found that several variables correlated with teachers' agreement or lack of it. The more teaching experience a teacher had, the less likely they were to agree. The more workshops teachers attended, the greater support they received from administrators; the greater industrial work experiences teachers had, the more they were in agreement with the new model. Putnam (1992b) asked state supervisors and one teacher from each state what they meant when they said that they taught technology education in order to assess change. He found that most of his respondents (71 percent) said they used the human adaptive systems of manufacturing, construction, communication, and transportation.

An interesting line of research was conducted by Rogers (1991, 1992), Rogers and Mahler (1992), and Linnell (1991, 1992). They used the Stages of Concern Questionnaire (SOCQ) to assess the openness of technology teachers to adopt and use changes in curriculum. In 1991 and 1992 Rogers reported about Nebraska's teachers, "the majority of industrial arts teachers have failed to accept or adopt technology education . . . and more experienced industrial arts teachers . . . are refocusing technology education prior to adoption" (p. 11). In 1992 Rogers and Mahler, in comparing Nebraska and Idaho teachers, found that most Nebraska teachers had not progressed beyond the personal stage of innovation and that the majority of Idaho's teachers indicated that they did not accept the changes. Linnell (1991, 1992) corroborated these findings with North Carolina teachers and found that the majority of teachers were at the personal stage. Being at the personal stage means that the teachers are aware of the changes, are very concerned about how change will affect themselves, but have not actively done more than investigate the issues.

Thinking along the same lines, a team of researchers evaluating the Illinois curriculum change process created their own, but similar instrument to assess teachers' stages of concern regarding change. The instrument was designed particularly for technology educators and the researchers developed it for not only Illinois, but also the nation (Dyrenfurth et al. 1993). They found that most teachers in Illinois, even after inservice work on curriculum change, were in a conservative to open-looker stage. This stage is similar to the personal and exploration stage of the

SOCQ. Most interesting is that they tested several groups of teachers and found no significant differences between teachers who were identified by others as traditional and a random sample of teachers who had taken curriculum inservice training. However, they did find differences based upon age with younger teachers showing more interest in change.

Summary

The studies assessing teachers' attitudes created a picture of the problems with the change process. It appeared as though younger teachers were more interested in technology education. Yet, the practice of the majority of teachers was open to question based upon their stage of concern with innovation in technology education.

Ideology, both the current and the historical influences in the field, provided a strong inclination toward vocationalism and skill development. This ideology was ever present in contemporary technology education practice, and it created the gap between what technology educators said they were and what they did.

Ideology was ever present in contemporary technology education practice, and it created the gap between what technology educators said they were and what they did.

With respect to creating a framework for change, researchers identified the need to provide curriculum materials for all teachers in order to improve the chance of creating change. In addition, it appeared as though the support of the school principal and administration was important to sustain change. Although these factors could aid in changing curriculum practices, the ideological problems persisted at such a deeply ingrained level that there was incomplete change.

Summary

What is known about technology education curriculum as a result of 7 years of research? The field is changing, superficially. The name of the field and the course titles both in secondary and teacher education have changed. The attitudes of teacher educators and supervisors have changed and technology education is clearly the favorite. Change in practice has either not taken place or there is no research which demonstrates that a significant change in practice has taken place. Moreover, there is research evidence from select locations that practice is still very traditional. A great deal of literature exists that may superficially address technology education, but in the deeper meanings and messages resort to vocational education practices. For example, vocational methods for deriving technology education curriculum are still used.

The superficial nature of the changes in technology education seems to be apparent to others such as school principals who have noticed the lack of change in practice in their schools. It does not always appear to be apparent to technology educators who seem to be buried by the superficial, rather than the deeper ideological battle that they are fighting with themselves. Implementing truly general education practice in technology education has not been accomplished or addressed in the literature. It needs to be done.

Implementing truly general education practice in technology education has not been accomplished or addressed in the literature.

Curriculum development through research efforts has been spotty, usually meeting the interests of the researchers. Delphi studies were the norm for curriculum development done as a research project. These studies generated expert opinions from a variety of experts about what ought to be taught in technology education. All of this research is influenced by personal ideology and researchers ought to be careful about selecting panels based upon ideological bias.

Examining the Profession

The second largest category was research that looked at various professional issues within technology education. Teachers, teacher educators, and college students were the primary targets as researchers wondered about technology education jobs and professionalism.

Secondary Teachers

As researchers studied secondary school technology teachers, they focused on two major areas: certification standards and the culture of teaching. Under each of these categories were a wide array of studies.

Certification

Many researchers sought to identify certification standards. In 1991 Bell looked for national certification requirements for technology education by collecting each states' certification documentation and interviewing state certification directors. He concluded that no nationally accepted certification model existed because there was no nationally accepted curriculum model. In Ohio Wright and Devier (1989) also identified a problem with a discontinuity between the curriculum and credentialling requirements that had not caught up to the newer curriculum. Wicklein (1991) asked state supervisors of technology education about certification requirements and found that 70 percent of the states used a certifying examination with no clearly favorite examination. Most states used either the state or the National Council for Accreditation of Teacher Education or a combination of them as an accrediting agency. There was "no consensus on the procedure and method of certifying Technology Education [sic] teachers in the United States" (p. 25). Martinez (1990, 1992) asked state supervisors, teacher educators, and local supervisors for information about certification for the new Principles of

Technology Program. He found that only 6 states required credentialling for Principles of Technology and 31 states accepted credentialling in technology education, physics, science, or vocational education.

Culture

Researchers approached the study of the professional culture of technology education in many ways. Some of these dealt with job satisfaction, the role of professional organizations, critical issues perceived by teachers, and the role of minorities in the field.

Job satisfaction. Generally describing the teacher population in two states, Wright and Devier (1989) in Ohio and Quon and Smith (1991) in Nevada found an overwhelmingly male population of teachers, 99 percent in Ohio and 98 percent in Nevada. In a 1990 study with a 36 percent return rate from 1,000 randomly selected ITEA members, Scarborough found that 96.3 percent of the respondents were male, 50 percent of them were under the age of 45, and 62.2 percent of them listed their program type as industrial arts rather than technology education. The teachers who returned surveys were positive about their job environment, but believed that funding for professional creativity and development was poor.

Assessing job-related stress and morale of teachers in Florida in 1987, Mathews found that the greatest source of stress came from poor pupils and the most frequent cause for low morale was poor facilities. In an indirect approach to identifying what problems were on the minds of technology teachers, Bjorkquist and Swanson (1987) asked teachers attending a regional meeting in Minnesota what they would do with $10,000 if they suddenly had a windfall with no restrictions on spending. The teachers responded with plans to purchase new hardware, advanced technical hardware, first, and conventional hardware, second. Then, they would work on professional self-development. Edmondson (1988) attempted to assess burnout of male technology teachers in Connecticut. In general he found that younger teachers and the oldest teachers reported the least emotional exhaustion with overall scores for emotional exhaustion in the lower average range, depersonalization in the low range, and personal accomplishment in the upper average range. In 1991 Wright studied retention of teachers by surveying state supervisors who said that a lack of support by the administration and salaries were sources of dissatisfaction for teachers.

Lin (1989) surveyed professionals to determine trends and issues in technology education. He identified philosophical factors, problem factors, solution factors, and prospect factors for consideration. Interestingly, Jui-Chen Yu (1991) found that position and salary contributed significantly to the job satisfaction of technology teachers in Taiwan. Wicklein (1992, 1993b) asked members of the profession, including teachers and teacher educators to identify the problems they perceived as important in the field. In the opinion of the panel, curriculum development as a process, a knowledge base for technology education, and interdisciplinary approaches to technology education were the three most prominent problems.

Studying an environment with qualitative methods, Little (1992) researched aspects of professional communities in comprehensive high schools. He identified two cultures: an academic culture and a vocational culture of which technology teachers were a part. In discussing the inability of these two cultures to integrate, he suggested that university faculty should require students to participate in integrated courses and programs.

Professional development. Professional associations were studied by three researchers. In 1987 Scarborough surveyed 1,300 randomly selected ITEA members. The 28 percent who responded to the survey provided a fairly mixed message about ITEA member needs. In 1990 Reeve identified organizations focused on technology education and found 10 organizations: 6 focused on teacher educators and 4 on classroom teachers. Nine of the organizations provide some sort of publication. Wicklein (1990) surveyed the membership about the need for a name change and found that 62 percent of the Technology Education Division of the American Vocational Association (TED-AVA) members belonged to the ITEA and 84 percent of the TED-AVA members supported the name change. With respect to the role played by the TED-AVA, 86 percent of the members wanted the organization to take a greater part in the leadership of technology education.

With respect to professional self-development, Ellis (1989) surveyed Michigan technology teachers to find their frequency of participation and preferred methods for professional development. She found that about half of her respondents participated in reading, professional dialogue with colleagues, and participation in local professional meetings. They preferred industry-based technical workshops, rather than locally designed workshops, and they preferred those workshops to be conducted during the school day. Tracey (1993) found that Connecticut teachers participated most frequently in those professional development activities which were required by conditions of employment or certification, but that they believed voluntary professional development activities such as attending conferences and meetings to be more beneficial than required development activities.

Minority participation. Two historical studies focused on the role of minorities in technology education. To create a record of minority participation for the field, a study by Larke (1987) about Booker T. Washington's encouragement of African Americans to participate in practical arts education should be noted. Equally important is the notation of the record of the participation of women in the history of the field. Dunlevy (1988) provided some of this record in a dissertation focused on the contributions of women to the National Society for the Promotion of Industrial Education. Although both of these studies are related to vocational education, each, due to the educational practices of the time, was related to an often overlooked part of the heritage of technology education, minority participation. Minorities have always been a part of the culture of technology education whether or not their efforts were recorded.

Teacher Education

Teacher educators have researched several aspects of their professional practice. They have been interested in how to recruit students, the role of the professor, and leadership in higher education.

Recruiting

Three researchers, McClung (1987) and Isbell and Lovedahl (1989), in two separate studies asked questions about recruiting students into teacher education programs. McClung described the role of teachers in Arkansas as recruiters for the field and concluded that all teachers can be recruiters, but those with higher educational attainments were more likely to recruit. Isbell and Lovedahl surveyed other teacher educators in order to identify successful recruiting techniques and found evidence which corroborated McClung's study. For teacher educators, contact with former students who were now teaching was the best form of recruiting. Other sources of students included referrals from community colleges and technical schools, especially for smaller colleges.

Professors

A few researchers tried to describe the role of the professoriate (Erekson and Gloeckner 1988; Paige and Dugger 1988). Paige and Dugger found that in a 20 percent sample of the people listed in the ***Industrial Teacher Education Directory***, 60 percent hold a doctorate, and 35 percent hold master's degrees. Most faculty had an average of 14 years of experience with 11 years in one place. More than half of the sample belonged to ITEA with other association memberships less prevalent.

Wey and Estepp (1987) assessed the professionalism of the professoriate through what professors were teaching their students about professionalism and found that those aspects of professionalism in which professors were weak were not taught to students. In class most professors put emphasis on attending conferences and reading publications and deemphasized research, grant writing, and textbook writing.

With respect to writing for publication, Litowitz (1990) did a descriptive service for the field by identifying and describing 10 journals associated with the field. In order to describe the scholarship of technology teacher educators in a way that has been growing in popularity for the purpose of promotion and tenure decision making, Post, Scott, and Hameed (1989) identified and ranked scholars in technology education by using citation indexing to create a list of the most frequently cited authors in the field. They concluded that since many of the journals in the field are not included in citation indexes that technology professors could suffer at promotion and tenure time.

Leadership

Leadership was on the minds of several researchers who attempted to describe that role in teacher education. Rider (1987) looked at the professional development needed for being a department leader and concluded that on-the-job training was most appropriate and that adequate preparation for the job was difficult until the role was assumed. Paige and Wolansky (1990) studied facets of the administrator's role. By surveying department leaders they found that perceived responsibilities included providing leadership in governance, curriculum, budget, and control. They also found a high turnover rate in administrators. The same team (Paige and Wolansky 1991) surveyed a small sample of deans in order to get their opinions about what was important in selecting department chairs. The deans identified creativity, scholarship, good teaching, grant getting, and sound fiscal management in the characteristics of administrators.

Surveying administrators in the field for their perceptions on minority participation in the field, Mann(1990) found that, although administrators admit to a lack of minority participation, their own record on encouraging minority participation was poor, and the issue of minority participation was not high on their agendas.

College Students

Several topics of interest concerning college students were researched. Litowitz (1988a) described technology education college student associations and found that of the 41 Technology Education College Association chapters, less than one-third of the students were enrolled and less than one-half of those students were active.

Arnett (1988) compared the aptitude scores of five types of education majors and found that technology education majors scored the highest on visual pursuit and mechanical reasoning. He also found that academic performance within the major was best predicted by numerical reasoning and general reasoning for technology education majors. Examining the relationship between Scholastic Aptitude Test (SAT) scores and the academic success of technology education majors, Wescott (1989) found an average SAT score of 800 and a grade point average (GPA) of 2.75. The Mathematics SAT scores were found to have the most significant relationship to GPA.

Studying burnout for teacher education majors, Edwards (1990) compared seniors in technology education, human services, and engineering at California State University in Long Beach and found that technology education majors are not prone to burnout and have attitudes about life and work that are similar to engineering majors. Murwin and Matt (1990) had student teachers at the University of Georgia rank order fears concerning student teaching and found their greatest concern was about discipline with student relationships next, followed by dealing with supplies and materials.

Technology education is a homogeneous profession and culture. The professionals are overwhelmingly male.

Providing Inservice Training

Daugherty and Boser (1993) recently completed a study of technology teacher education programs with five or more graduates in 1991 in order to examine the degree and type of involvement that teacher educators had with providing inservice education. They found that over half of the programs reported involvement with inservice programs. Of those involved, most of the programs involved curriculum updating and "hands-on" instruction. Although teachers provided guidance for many of these programs, teacher educators provided the leadership for the efforts.

Summary

A few themes about professional issues emerge from this mix of studies. Technology education is a homogeneous profession and culture. The professionals are overwhelmingly male. They are not very concerned with minority participation in their field, which is evident through both the lack of research about minority participation and the results of the study which was reviewed. Technology educators are also concerned about standardizing credentials, a way of ensuring further homogeneity. At present, no standardization has been identified and most researchers have blamed that on the lack of a consistent curriculum model.

Although professional development opportunities exist, technology educators reveal themselves to be not very active, professionally. Those habits may well be formed in college. Both at the teacher education and the secondary school levels reading seems to be the most frequent form of self-development. The few studies reviewed in this paper further corroborate the lack of interest in doing research among most university faculty of technology education.

Although professional development opportunities exist, technology educators reveal themselves to be not very active, professionally.

Once they overcome student teaching fears, technology educators seem to derive job satisfaction from the equipment, tools, and machines with which they work and their salaries. Technology educators are, it appears, more concerned about the facilities within which they are to teach than the students whom they teach.

With respect to teacher education, practicing teachers were considered to be good recruiters. Once involved in teacher education, students did not participate in large numbers in professional associations designed for them. Technology teacher education majors also had profiles similar to engineering majors.

Most teacher educators have a doctorate and average at least 14 years of experience. More than half of them belong to the ITEA. Program leaders in technology teacher education are expected to perform a wide array of duties while maintaining standards of scholarship. Training for program leadership is done on the job.

Improving Instruction

As technology education researchers studied instruction they chose a wide variety of diverse topics. From perceptions of instruction to the effects of manipulated instructional variables, researchers attempted to learn more about several aspects of instruction and technology education.

Perceptions

Observing secondary students in Quebec with the Observational System for Instructional Analysis, Milette (1988) determined that the system was helpful for teacher preparation and that alternative instructional strategies such as developing interest centers facilitate productive student and teacher interactions in the classroom. Surveying Technology Student Association advisors who attended a leadership seminar, DeLuca and Haynie (1991) sought the teachers' preferred technology education teaching strategies. The teachers reported that they used the following in order of frequency: demonstration, lecture-demonstration, individualized instruction, individual projects, lectures of 10-25 minutes, group projects, laboratory experiments, discussion, student-designed or -selected projects, and teacher-designed or -selected projects.

Problem Solving

Problem solving has been endorsed as a core instructional strategy for technology education and several studies have been conducted about it. In 1987 Hutchinson introduced British problem solving by categorizing the process into five means of using the technique: demonstration, oral description, written depiction, graphic representation, and three-dimensional modeling.

Six studies described the role of problem solving in technology education. Ceccarelli's (1987) survey of teacher educators determined that problem solving and design were not being adequately addressed in teacher education. Seymour (1990) had Indiana teachers rate the ways in which the existing curriculum addressed problem solving. They identified 140 activities that appeared to promote problem solving. Boser (1991) interviewed experts in order to identify means of preparing preservice teachers to use problem-solving methods. The panel's response centered around using problem-solving techniques in teacher education. Doyle (1991) identified physical factors that contributed to problem-solving activities by surveying the literature and reviewing videotapes of practice. These were ranked with information resources, extended learning environments, prototyping areas, design areas, and ambient areas for thinking as the top five physical factors on the list. DeLuca (1991b, 1992) surveyed outstanding teachers who were recognized by the ITEA for the problem-solving activities that they used. His results were disturbing in that giving students control of the activity was the least frequently used strategy and lecture, discussion, demonstration, and experimentation were listed by the teachers as the most frequently used methods. In 1993 Boser surveyed a select panel of experts in problem solving and technology teacher education to develop a list of methods and strategies for improving problem-solving instruction in teacher education. Small-group problem solving was ranked as the most used strategy.

Two researchers sought to evaluate ways of improving problem-solving practices. In 1992 Glass had students think aloud during problem-solving situations and compared their results to students who did not. He found that the thinking aloud procedure appeared to aid the students. Sanfilippo (1992) tried evaluating the use of the Osborn-Parnes method of creative problem solving and found that, although it was a somewhat effective model for teaching creative problem-solving skills, students with adaptive problem-solving styles responded no differently to its use than students with innovative problem-solving styles.

One researcher looked at the overall contribution of technology education instruction to critical thinking. In a quasi-experimental study designed to assess the effect of technology education instruction on critical thinking, Mahoney (1993) found no significant differences on tests of critical thinking ability between eighth-grade students in Kentucky who had been exposed to technology education and students who had not been exposed.

Testing

Testing in general was a topic of research that concerned several researchers. A series of studies conducted by Haynie (1990, 1991, 1992) addressed the role of testing in instruction. With a population of intact eighth- and ninth-grade classes in 11 schools, Haynie (1990) tested the effects of anticipation of tests on learning videotaped material. He found that, with these students, announcing a test was effective if the test was given as announced. In 1991 he used North Carolina State University technology education students to test the effectiveness of take-home and in-class tests on delayed retention of learning via individualized instruction. He found that testing promoted retention in learning, but there was no significant difference with the type of test given. Continuing an interest in testing, Haynie (1992) rated technology teachers' ability to construct tests. Using a population of 15 teachers selected to work on the project, he provided training in test construction, had them create tests, and coded the results for errors He found significant differences in teachers' abilities to construct tests.

Mentally Challenged Learners

Two researchers, Cunningham (1987, 1988) and Spewock (1990), investigated mentally challenged learners in technology education. Cunningham (1987) reported that when using enablers to aid in manufacturing a product, no significant differences existed between mentally challenged learners and a sample of students who were considered to be mentally capable. In 1988 Cunningham also reported that using the same activity, mentally challenged students performed equally as well as those students judged to be mentally capable. Spewock (1990) tested the effects of using task analysis cues to aid mentally challenged students in the assembly of an engine and found that the cues were effective, but he had no comparison or control group to judge how effective these cues were. In 1992 Pullias did an ethnographic case study to interpret the effects of mainstreaming challenged students into technology education. Although he found no major problems, he indicated that most of the mainstreamed students were not participating in all of the class activities. Since the teachers received no inservice preparation, he suggested orienting teachers to dealing with the challenged students.

Computer-Related Instruction

In 1988 Hu queried Colorado teachers about computer-assisted design (CAD). He found greater barriers with respect to financial, facilities, and equipment implementation concerns of CAD for technology teachers as compared to vocational teachers. In the same year Chuang (1988) surveyed college students to examine the relationships between computer and tool anxieties. The number of courses taken in each area reduced anxiety, academic major influenced anxiety, gender differences affected anxiety levels, and mothers' educational level was found to be the most reliable predictor for computer and tool anxiety. Butler (1991) assessed the performance of college students registered for drafting at Appalachian State University on achievement based upon exposure to either traditional drafting or CAD. He found no significant difference in cognitive achievement, but lower performance of skills on the part of the CAD group. Young-Hawkins, Householder, and Winterberger (1991) found no significant differences on tests of knowledge among college manufacturing students who used a computer simulation versus a manufacturing activity. Crain (1992) studied computer-assisted instruction (CAI) in Texas vocational and technology education programs and found significant differences in the use of CAI in the two programs with less use of CAI in technology education. In an action research study Ryan (1992) did a qualitative evaluation of the effects of senior high school technology education students teaching a CAD unit to fifth- and sixth-grade students. Some of the many findings included an increase in the technology students' self-esteem, interest in teaching, and belief in technology.

Cognition

Using three symbol systems, modeling, short-circuiting, and activation to introduce orthographic projection to sixth-grade students, Heuberger (1987) had mixed results leading to no clear method of choice. In 1987 Murray studied the effects of technology forecasting on improving the learning of junior high school students in technology education with no significant results. Siebold (1989) found that concept organizers helped in a study of the differences between schemata and concept organizers in cognitive learning with college students. Peterson, Ridenour, and Somers (1990) studied the effects of two methods of teaching measurement—the fractional method versus the line method—to sixth-grade students in technology education. They found that the line method worked better for teaching measurement and, surprisingly, teaching fractions. DeLuca (1991a) found that a mathematical organization of text structure helped a small group of North Carolina State University undergraduates who had no previous experience in manufacturing with comprehension.

Safety

Teaching laboratories are more hazardous environments than classrooms, and several researchers looked at safety instruction. Petty and Pierce (1988) surveyed a sample of Tennessee teachers and their administrators and found that both groups perceive a need for safety training. Plabbe (1991) surveyed junior and senior high school teachers and found that the majority were not using hearing conservation devices or enforcing the hearing safety laws even though they enforced eye safety. Andrew (1991) also concluded that Maryland teachers did not practice hearing conservation.

Related to safety is a unique study of elementary school girls' use of tools. Trautman (1989) tested the girls to determine the effects of tool size on their use of the tools. She determined that size of the tool made a difference regardless of instruction and that instruction should focus on proper motor patterns rather than output.

Summary

A very skimpy research base exists with respect to the exploration of instructional methods and strategies. Moreover, a number of "method A versus method B" studies have conformed to the common result of inconsistency with respect to significant difference. This state of affairs does not lead to themes emerging from the research. Perhaps the greatest theme emerging from technology education research about instruction is what is missing from the research.

Cognition is a prominent research topic in many subject fields such as science and mathematics. Very little research has been conducted on the topic and what has been done does not create a theme or provide much guidance.

Perhaps the greatest theme emerging from technology education research about instruction is what is missing from the research.

All technology educators deal with special needs students. Yet, only three studies indicate that there are some enablers which can ensure that challenged students can succeed in the classroom. There is too little information about instructional strategies that would help physically and mentally challenged students.

Computer-assisted and computer-based instruction should be integral to technology education. It appears that it is not being implemented as rapidly as it should be in technology education. However, there is no significant body of research about either implementation or the effects of CAI.

Problem solving is offered in the literature as a prime method of teaching technology education, yet studies about problem solving are relatively few. There is an indication that problem solving is not being done, even by teachers who have been recognized as outstanding. Teacher educators are just beginning to identify what should be done in their programs with respect to using problem solving as a teaching method. In addition, only a few researchers have begun to evaluate the efficacy of problem solving as an instructional method.

Technology educators were not spending much research time on instruction; therefore, there were no patterns of information about how to improve the practice of technology education. The research topics did not form coherent patterns leading to corroborated conclusions that could reform practice. The practice of technology education was identified as problematic in the previous section. It is the discontinuity between what is prescribed through curriculum as theory and what is actually done in the classroom through instruction as practice that creates the theory and practice chasm that affects technology educators.

Effectiveness and Integration of Technology Education

When researchers attempted to demonstrate some of the benefits of technology education, they turned most frequently to trying to demonstrate that by studying technology education, performance in another area or subject improved. A few international researchers approached the problem by trying to demonstrate or assess some inherent value of technology education.

Unique Values

In the Netherlands, Streumer and Doonekamp (1988) tested a 1,805 member stratified random sample of 14- and 15-year-old students for achievement in technology knowledge. They found a positive correlation between school achievement and technology achievement with students from junior technical schools scoring the highest. Girls' scores were low overall, gender accounting for 39.3 percent of the test score variance, with the students in domestic science having the lowest scores. In 1988 Streumer also tested a large sample of 12- to 13-year-old students, finding that 43.3 percent of the variance on test scores was accounted for by the factor of the students' achievement level.

In 1991 Kimball, Stables, Wheeler, Wosniak, and Kelly evaluated the effectiveness of performance in design and technology in England. Their document provides a unique qualitative method for assessing performance of design in technology education. Shield (1992), also interested in assessing performance and learning in technology education, used qualitative methods to study two comprehensive secondary schools in northeast England. He concluded that stating objectives, planning work relevant to students' experiences, reducing the demands of the role of facilitator on teachers, and providing stimulating work environments were all important factors in technology education.

Technological Literacy

A test of technological literacy was developed and pilot tested by Hameed (1988). He sampled 1,350 students from 13 states and set norms for the test. Gender differences produced no test bias. In the validation of a test of technological literacy, Hayden (1989, 1991) found that high school males in Mississippi scored higher than females on most items and that their fathers' contact with tools was significantly correlated with their scores. He also found that those who had taken technology education scored significantly higher that other students. Shearrow (1992) used Hameed's test to study middle school students in central Ohio. Even though all students' scores were low, he found that school expenditure correlated positively with the manufacturing scores of students and age correlated positively to students' performance on the communication section of the test. He concluded that many problems remain with testing for technological literacy. Kuforiji (1992) developed and piloted a test of technological literacy. She found that of the senior high school students who took the test, there was a low level of technological literacy.

Science

In 1987 Ekwunife did a qualitative study of Nigerian students participating in an informal study of technology and science via field trips to a variety of sites where there were technological activities. He concluded that these were motivating for students.

Several researchers studied the effects of the Principles of Technology Program on students' performance in physics. In a summative evaluation of all students' achievement after 1 year of the course in Iowa, Hall (1989) reported significant improvement in physics knowledge, no differences based upon gender and grade level, and differences based upon school size and grade level. In 1990 Lewis compared performance on a physics exam of students from eight pilot Principles of Technology Programs and a control group of physics students. He found no significant differences on test scores between the groups and concluded that the new program might help to bridge the educational gap for some students. Nicholson (1991) tested students who had 1 year of the Principles of Technology Program with a normed physics test and found that the students scored low, not statistically different than a chance score. Dugger and Johnson (1992) compared the physics performance of 15 high school students who completed the Principles of Technology Program with a control group using a test developed for the new program. They found that there had been a significant gain in the physics performance of the students who had the program, but caution that the test was biased to the program.

In a rare study focused on elementary school children, Brusic (1991) examined the effects of a technology activity integrated with a science unit on the students' achievement and curiosity. She found that the activity may positively influence the students' curiosity, but that there was no significant change in achievement.

Mathematics

Rogers (1989, 1990) used data from the National Longitudinal Survey youth cohort in order to assess the effect that enrollment in technology education had on students' mathematics performance. He found no overall correlation, but with the selected students who had courses in drafting and electrical/mechanical he found a significant difference in mathematics grades. Korwin and Jones (1990) tested 50 eighth-grade students to determine if technology education activities improved performance in mathematics and found a significant difference in next-day testing as well as consistent results on retention tests.

Language

Ilott and Ilott (1988) analyzed the transcripts of 10 elementary school students' written explanations of technical processes and found that contextual writing in technology education not only encourages students to use all forms of language, but also encourages the use of less common forms such as passive voice.

Career Concerns

Studying the effects of exposure to technology education to realistic career choices, Shea (1987) found that seventh- and eighth-grade technology education students from 18 schools made more realistic career choices. Looking at employment, Doty (1991) found that in a telephone survey in Somerset County, New Jersey high school graduates identified technology education as one of the most helpful courses for employment.

Related to career concerns, Petty and Hanson (1989) studied children attending a summer youth camp and recorded in an ethnography what he interpreted as some of the effects of technology education participation. The camp experience appeared to have improved students' ambition, self-control, organization skills, enthusiasm, and conscientiousness. Forester (1991) studied the self-concept and locus of control of underachieving African American and Hispanic seventh-grade students who had taken technology education electives. Male Hispanic students scored significantly higher on the self-concept test, but there were no other significant differences on any other comparisons among males, females, and the control group.

Summary

Few studies attempted to demonstrate the inherent value of technology education.

Does technology education make a difference? Most of the researchers tried to place technology education in the position of method, a method used to improve the performance of students in subjects other than technology education. The results of these studies were mixed. At times, it appeared to make a difference to have taken a technology education class, and at times there was no difference. This pattern of results mirrored the prevailing pattern of "method A versus method B" studies in instruction. In addition, these studies were misdirected in that many focused on achievement in subjects other than technology education.

Few studies attempted to demonstrate the inherent value of technology education. Again, it was the international researchers who had their "eyes on the prize" and conducted studies that attempted to identify the effectiveness of technology education as a unique subject. Those international researchers found that academic ability and gender mattered with respect to conceptualization of technology. They also provided insight into teaching and evaluating performance in technology education.

It is amazing that, although technology educators in the United States tried to create a unique body of knowledge for technology education and search for the defining characteristics of a discipline of technology, researchers tried to demonstrate the value of studying technology by showing an improvement in some other already established subject matter! This just might be wasteful of research time. A lesson could be learned from those who have been able to establish national mandates for the study of technology education in their countries: conduct research aimed at demonstrating the unique characteristics and value of technology education.

Attitudes toward Technology Education

Several researchers have attempted to assess public attitudes about technology education as well as technology. The attitudes of the public, school administrators, teachers, and students were obtained in the few studies conducted on this topic.

The Public

Based upon dissertation work, Bebee and Blankenbaker (1987) reported on a telephone survey of the public in Columbus, Ohio. They found that people who had taken industrial arts and males were in favor of offering technology education in the schools. They also found that people believed that the adaptive systems curriculum was as important as the traditional curriculum and over 70 percent of their respondents believed that technology education was as important as science education.

School Administrators

Several researchers sought opinions about technology education from school administrators. In Mississippi Johnson (1987) and Omoregie (1991) surveyed administrators and counselors about technology education. They both found that technology education was viewed in similar light as the other school subjects and was considered to be a valuable school subject. In Ohio Draghi (1991, 1993) surveyed school decision makers and found that they were knowledgeable about contemporary technology education and believed both traditional and contemporary goals to be worthwhile, supporting the inclusion of technology education as essential general education. In Illinois Daiber (1990) surveyed school principals and found a .6 correlation between their knowledge of technology education and their attitude toward implementing the program.

Teachers

Reid (1989) surveyed both teachers and students about craft, design, and technology (CDT) programs in Northern Ireland. Among CDT and non-CDT teachers he found a general acceptance of the value of CDT. Daugherty (1991) and Daugherty and Wicklein (1993) reported on dissertation research that assessed the attitudes of exemplary technology teachers and their mathematics and science colleagues. They found that the teachers agreed upon the value of integrating knowledge in the three subjects and that they all indicated that teaching biological systems in technology education was the least valuable curriculum content. However, there were differences in the teachers' perspectives about the characteristics of technology education.

Students

A series of studies have been conducted in the Netherlands in order to assess students' attitudes about technology. One of the latest studies (Wolters 1989) indicates that 12- to 13-year-olds had positive attitudes toward technology and poor conceptions of it, but that there were differences with respect to gender. Boys were more positive toward technology and had a more positive technical self-concept. Reid's (1989) study of Northern Ireland also addressed variations in students' perceptions based upon gender. He found that females were aware of the biases in the classroom and reported differential treatment. Female students as well as Catholic students reported a disadvantage with respect to access to CDT.

Bame and Dugger (1990) and Bame, Dugger, and deVries (1993) replicated the European Pupils' Attitudes toward Technology (PATT) studies with 10,000 middle school students in the United States and made comparisons. They found similarities in that there were gender differences; boys had more positive attitudes and girls, after taking technology education, thought that the field was male oriented! Parental involvement and occupation also contributed to more positive attitudes. In general, students in the United States had a weaker understanding of technology than students from other countries where the studies have been done.

Summary

Although few in number, all of the studies about technology education revealed positive attitudes on the part of the public, administrators, and teachers with respect to the need for technology education in the schools. Even traditional industrial arts goals received an endorsement from the public, administrators, and teachers. It is questionable what women believe about technology education; males appeared to have a higher regard for technology education.

Theoretically, technology educators believe that technology education is a subject of study for all. Practically, girls do not believe this.

Pupils' attitudes toward technology were assessed by international researchers and a team of researchers in the United States. Their results, combined with some of the related studies about the effectiveness of technology education that were conducted in the Netherlands and Northern Ireland all have disturbing conclusions with respect to gender differences in both conceptualization of and attitudes toward technology and technology education. Theoretically, technology educators believe that technology education is a subject of study for all. Practically, girls do not believe this. Moreover, in the United States girls who were exposed to technology education were more convinced that technology was a male endeavor! It appears as though the way in which technology education is taught is leading to a misconception by and a miseducation of girls.

Comparisons of the pupils' attitudes studies between the United States students and foreign students also reveal a disturbing result: students in the United States had a weaker conceptualization of technology. Even the variables that had positive correlations in the studies—parental involvement and occupation—were not good support for the inclusion of technology education in the schools' curriculum. Although this evidence is preliminary and there are not enough corroborating studies, the evidence should serve as a warning to the profession to examine its practice seriously. Although many people endorse the idea of technology education, evidence that the practice of technology education either makes no difference or further exacerbates a societal problem such as gender equity could be damaging to the field. A lack of support from the majority of the population, women, could damage the future of the field.

Final Words

In the final analysis, what is known about technology education? The most information exists about curriculum, a bit about the professionals in the field, little about instruction, less about its effectiveness and attitudes toward technology and technology education. A majority of the studies were descriptive, and most of the descriptive studies dealt with people's attitudes, rather than demographic or other types of data. Moreover, the kind of research that was conducted was largely positivistic in nature with an inherent bias in the topics chosen and questions asked. There were few surprises in the results, and it could be said that this kind of research leads to the affirmation and reproduction of existing value structures.

Curriculum

- The field is changing, superficially.
- The name of the field and course titles have changed.
- The attitudes of teacher educators and supervisors have changed.
- Teachers' attitudes toward technology education are characterized at the awareness stage.
- Research evidence from select locations shows that practice is still traditional.
- School principals have noticed the lack of change in practice in their schools.
- There is some evidence of a mismatch between attitudes and ideology about technology education and what is practiced for both teachers and teacher educators.
- Support of school administrators and having curriculum materials may enhance and sustain change in schools.
- Curriculum development through research efforts has been spotty.
- Delphi studies were the norm for curriculum development done as research.

There was some good news with respect to curriculum. Significant strides toward change were made at the leadership, teacher education, and state department levels of technology education. The data were clear that leaders in the field were trying to change the content and practices of technology educators. This, in itself, is no easy task. Comparing reform movements in other subject matter fields to the effort in technology education makes the technology educators' effort look heroic.

Curriculum evolution is a difficult and slow task. What is known, however, is superficial and the scant research that looks more deeply into curriculum status and change provided some disturbing insight into the entire curriculum revision process. Deeply rooted ideologies about the profession may be more difficult to change both in teacher educators and teachers. Teacher educators gave mixed signals with respect to beliefs and practices. Teachers had yet to accept and implement, in large numbers, the changes suggested by the leadership. Some school administrators were aware of this theory/practice gap or general confusion. Further investigation and effort is needed at the grassroots level of the profession, in the classrooms of schools and universities, in order to determine the true extent of change.

Some of the research indicated that the lack of innovative instructional materials was a problem. The meteoric rise in popularity of the modular technology education systems that have been recently assembled by commercial vendors corroborates this finding in the research. The success of these modules is a clue to teachers' hunger for technology education curriculum materials. At the moment, the critical effort may well be to provide a variety of technology education (as it is currently defined) curriculum materials rather than to create and recreate the content base of the field.

The kind of curriculum research that was done still involved creating taxonomies of content by asking for "expert" opinion through the use of Delphi panels. This indicates two problems: the need to find a method of identifying technology education curriculum and the need to move beyond taxonomies and focus on the creation and testing of classroom curriculum materials.

Task analysis methods of creating curriculum are inappropriate for technology education because these methods lead to identifying skills and processes which then become the foundation of content. Inevitably, these skills as content lead to a vocational spin on courses and instruction as skill and task instruction easily becomes the focus of the lesson. As a substitute for task analysis, a number of researchers have resorted to using a method generated for predicting the future, the Delphi method. This process was created to get experts to agree on mean responses of what the most likely scenario for the future might be. What this method does for curriculum is reduce the content to the mean response. This cannot lead to innovation, and, therefore, over the long term, becomes detrimental to further evolution in the field. Moreover, identifying and using industrialists as the only professionals who serve on Delphi panels provides an industrialist view of technology education. This kind of myopia is another subtle way in which the field becomes more like vocational education, rather than general education for all students. New ways of creating technology education curriculum are needed.

Perhaps it is the lack of clear materials for implementation that is inhibiting the full realization of technology education in classrooms.

In lieu of an appropriate method for identifying curriculum, putting the recreation of the technology education content base on hold and concentrating on curriculum materials for teachers could help to push implementation of technology education, as it is now conceived, into the classroom. Perhaps it is the lack of clear materials for implementation that is inhibiting the full realization of technology education in classrooms. Creating and implementing new curriculum materials would represent significant change and a major achievement by the field. The need has been established; the task remains to be completed.

The Profession

- The professionals are overwhelmingly male.
- Teacher educators are not very concerned with minority participation in their field.
- Technology educators are concerned about standardizing credentialling.
- Forming habits while in college from teacher educator examples, technology educators reveal themselves to be not very active professionally, using reading as the most frequent means of professional development.

- Once they overcome student teaching fears, technology educators seem to derive job satisfaction from the facilities, equipment, tools, and machines with which they work and their salaries.

Perhaps it is not that teacher educators are not active, but that they are not sharing and promoting their professional involvement with their students.

There was a bit about the technology education professionals who practice in universities and classrooms. There was some demographic data which indicated that they are a homogeneous population and they were not very active professionally. Both of these points can work to inhibit change in technology education.

First, the homogeneity of the professionals in the field leads to a closed circle of ideas. Similar professionals can reinforce the ideology and behavior of each other giving the profession a chilly climate for those who are different. Ultimately, this could lead to shutting out, inadvertently, new and potentially exciting ideas from underrepresented populations. Having a diverse professional population could help to make technology education a subject of study for all students.

Second, the lack of professional participation and development inhibits both personal growth and the eventual evolution of the field. Successful efforts to involve preservice technology teachers in professional development need to be identified and publicized. Accomplishing that task would then lead to the need to identify ways in which to improve the modeling techniques of teacher educators with respect to professional activity. Perhaps it is not that teacher educators are not active, but that they are not sharing and promoting their professional involvement with their students.

Instruction

- Unlike many other fields, cognition as a topic has received little attention.
- Instruction related to mentally and physically challenged students is scant.
- There is an indication that CAI is not being implemented as rapidly as it should be in technology education.
- There is an indication that problem solving is not being done, even by teachers who have been recognized as outstanding.

- Research about problem solving as a strategy for instruction is just beginning.

Coupled with the need to concentrate on curriculum implementation through materials development was the lack of research about instruction, its practice and effectiveness. The few studies related to instruction did not provide a sufficient map of the terrain with respect to the cognitive problems of teaching about technology or using the often touted problem-solving method of instruction. There was little knowledge about whether the profession is meeting the goal of problem-solving instruction or whether it is a reasonable goal.

Researchers in science and mathematics are creating a body of research knowledge about teaching the important concepts of science and mathematics. Once they have determined that there are concepts of value which lead to a greater understanding of technology, the role of researchers in technology education should be to explore and determine the value of the concepts, how and when students internalize those concepts, and how the concepts fit together to create a big picture of the how humans use and can benefit from the technology that they create.

Taken as a whole, these studies do more to convince one that technology education is not a subject in its own right, but a method.

Problem solving as content and as method could be one place to begin this kind of research. There are but a few studies of the role of problem solving in technology education, yet technology educators are accepting it, uncritically, as both content and method for technology education. There are also studies placing technology education in the role of a method to improve critical thinking skill. Those researchers who are interested in the proper role of problem solving in technology education have a great deal of investigation and explanation to do.

Too many studies are conducted about the role that technology education plays in improving learning in other subjects. Taken as a whole, these studies do more to convince one that technology education is not a subject in its own right, but a method. Is this a direction of research that the profession wants to continue?

Effectiveness

- Few studies attempted to demonstrate the inherent value of technology education.
- Research on technological literacy is scant and appears to be problematic.
- It was largely the international researchers who conducted studies that attempted to identify the effectiveness of technology education.
- U.S. and international researchers found that academic ability and gender mattered with respect to conceptualization of technology.

Few studies have been conducted in the United States about the effectiveness of technology education. Given the number of studies done to test improvement in mathematics, science, critical thinking, and other areas as a result of technology education exposure, researchers have been ignoring a fundamental question with respect to technology education. What is the inherent value of technology education? There is little evidence with respect to its value.

Researchers in the United States could begin to take the lead of the European researchers who are trying to establish a research base about technology education and its value. Only one team of researchers have initiated this kind of research; more is desperately needed by the profession in order to establish the case for the inclusion of technology education in the schools' curriculum.

As a result of the research on the effectiveness of technology education a recurrent theme appears to be developing both in the effectiveness research and this entire synthesis of research. Gender matters. There are differences with respect to gender in the effectiveness of technology education. These differences are not simplistic and there are a number of societal and professional factors which appear to relate to the differences. Attitudes about technology provide some of the clues, as well as the nature of the profession and subject matter.

Attitudes

- The public, administrators, and teachers have positive attitudes about the need for technology education in the schools.
- With males, having taken technology education may lead to positive attitudes toward offering it.
- In the United States girls who were exposed to technology education were more convinced that technology was a male endeavor! Girls in Northern Ireland were aware of bias in the CDT program.
- Comparisons of the PATT studies between the U.S. students and foreign students reveal that students in the United States had a weaker conceptualization of technology.

Studies about attitudes toward technology and technology education are few. Yet, those studies which have been done point to some interesting ideas for further research and thought about technology education. The public appears to be receptive to technology education, especially males who have been exposed to some form of it. Researchers need to explore this and try to decide how to use this information.

Researchers need to probe the inherent bias in the content of the field.

The attitude studies also reveal, more clearly, the problems inherent in the profession regarding gender bias. This does not mean, however, that gender bias would be the only bias inherent in the profession. A number of the studies that point to gender bias were completed in fairly homogeneous cultures in Europe where multiculturalism is not as important a question as in the United States. Researchers need to explore both gender and cultural bias inherent in technology education. There is an indication that girls who have taken technology education are aware of a bias. This bias is not simply interpersonal. In fact, that may be the least of the problems. Researchers need to probe the inherent bias in the content of the field. The limited topics chosen as appropriate for technology education and the kinds of activities chosen to illustrate concepts of technology are more likely to be the source of the bias in the profession. The traditional limitations upon content have focused on preparing young middle-class men to fit into the industrial society largely because young women were not perceived by society to need that kind of educational preparation. Today the tables have been turned and all students, of both genders, all cultures, and all abilities, need to have the best preparation possible with respect to creating, using, and living within a highly developed technological society.

Unfulfilled Promises

Perhaps the profession would be better off trying to fulfill one or two less ambitious goals, such as implementing technology education in the school and creating a subject matter that could be relevant to all students.

A concern and goal of the field has been to establish a discipline of technology education and with that to fulfill the goal of creating technological literacy. What is interesting is that no research has been done to this end. No discipline was created and none may ever be able to be created given the nature of people's involvement with and use of technology. Disciplines are formed when communities of scholars working together can agree that such a discipline exists. Technology educators are but a small part of the community of scholars who are technologists. Their role is to reflect the diverse nature of technology and, perhaps, to become a part of the greater body of scholars who form the foundation for a discipline of technology, not to create the discipline. Inherent in the problems of creating a body of knowledge for a discipline of technology was the lack of progress with defining the term technological literacy and creating a test of technological literacy. Although some research to this end was conducted, no significant results were reported. Perhaps the profession would be better off trying to fulfill one or two less ambitious goals, such as implementing technology education in the school and creating a subject matter that could be relevant to all students.

Based upon the demography of the population and studies related to other concerns, a picture of another unfulfilled technology education goal emerged. Technology educators are not addressing the needs of minorities, women, nor physically or mentally challenged students. It is not currently a subject for all children, nor does the leadership seemed to be concerned about this problem. Other than creating goal statements, little research and effort was being done in order to address the fundamental proposition that technology education should be offered in schools to all children.

Based upon my interpretations of the research (others may have different insights), I believe technology education researchers need to—

- expand the use of a variety of research methods,
- explore and demonstrate the inherent value of technology education,
- research cognition and conceptual attainment with respect to technology education,
- study the ideology and inherent biases with the content and practice of technology education in order to provide content and access for all students,
- determine and exploit public attitudes and receptivity to technology and technology education,
- develop and test curriculum materials in order to implement technology education for all students, and
- identify and promote effective professional development.

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